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NEW FUNCTIONAL FOOD FAT AND OIL PRODUCTS WITH A BALANCED FATTY ACID COMPOSITION

New functional mayonnaises with a balanced composition ω-3 and ω-6 fatty acids were developed.

Raw vegetable oils (sunflower, linseed, rape seed and corn) were selected and their compositions are investigated by using gas-liquid chromatography at the first stage. The investigation, fatty acid composition of natural oils showed that none of them can't to provide introduction of essential fatty acids into the human organism in the required quantity and right proportion.

The blends of vegetable oils with a balanced composition of polyunsaturated fatty acids was calculated in the second stage. Basic physico-chemical properties of the obtained samples of blends of vegetable oils were established.

In the third step, the functional mayonnaise recipes using obtained blends of vegetable oils have been developed. development types of mayonnaise were produced in the laboratory of JSC "Minsk Margarine Plant", it was defined their physico-chemical and organoleptic characteristics. It was found that the physico-chemical and organoleptic quality ratings, obtained mayonnaises meet requirements imposed on them in the fullest extent.

In the fourth stage, the fatty acid composition of the obtained mayonnaises was investigated. It is found that the mayonnaise retained their fatty acid composition during manufacture and storage, and consequently their functional properties.

The results of the research confirmed the possibility of the release of mayonnaise on the base of proposed blends, because they are fully meet by the physico-chemical and organoleptic quality ratings are established in the requirements of the standard STB 2286 "Mayonnaise and mayonnaise sauces. General specifications".

Key words: mayonnaise, functional food, polyunsaturated fatty acids, blends of vegetable oils, fatty acid compositions, gas-liquid chromatography.

Introduction. Adverse environmental conditions, the lack of free time for relaxation, poor diet subsequently leads to a decrease in functional activity of the digestive system of the body and its gradual depletion, the development of a number of diseases with abnormal lipid metabolism.

To maintain the body in proper state the diet of people began to incorporate various biologically active supplements, which in most cases worn to the class of natural food components and have strong physiology-related and pharmacological effects on major regulatory and metabolic processes of the human body [1].

Due to the production lines biological active additives are divided into pharmaceutical and food products (functional food products) used for daily nutrition and further enriched in the process-all production of active substances (components), not previously present in these products.

The biologically active components of vegetable oils, normalizing lipid exchange, primarily include polyunsaturated fatty acids (PUFAs) – linoleic (ω-6 family) and linolenic (family ω-3) [1, 2].

PUFAs are involved in the body as structural elements of biomembrane of cells. They help to regulate metabolism in cells, normalize blood pressure, platelet aggregation; effect on cholesterol metabolism, stimulating its oxidation and excretion from the body; have a normalizing effect on walls of blood vessels; they are involved in the metabolism of B vitamins; stimulate the body's defense mechanisms, increasing resistance to infectious diseases, the effect of radiation and other damaging factors; the cellular hormones of the prostaglandins are synthesized from PUFAs.

One of the main products of oil industry, often used in the daily diet is mayonnaise.

Multicomponent composition of mayonnaise provides wide opportunities for designing products that prevents deficient states in essential fatty acids, vitamins and other physiologically functional components.

The aim of this work is to develop a new type of mayonnaise, the production of which are used blends of oils having fatty- acid composition with a balanced ratio of essential fatty acids ω-3 and ω-6.

Main part. One of the main components of the mayonnaise emulsion is refined, deodorized oil. To create mayonnaise for the functional purpose we examined a number of vegetable oils which are the most widespread in the Republic of Belarus and poorly understood ones, which can be used as additives to the blends of plant oils, providing an appropriate balance of PUFA for further use in the composition of the composite mixture, possessing curative properties.

While choosing the compositions of vegetable oils we were guided by the following – the ratio of

ω-6 : ω-3 acids in triglycerides should be close to optimal, providing preventive properties of the product.

Taking into account the cost and the possibilities of import substitution of expensive domestic raw materials for blending the following oils were selected:

– sunflower refined deodorized;
– corn refined deodorized;
– rapeseed oil refined deodorized;
– flax food.

In the first stage the fatty acid composition (FSWs) oils by gas-liquid chromatography (GLC) was investigated. For carrying out chromatographic studies initially the obtaining methyl esters of fatty acids was performed.

Preparation of methyl esters of fatty asids was carried out in accordance with GOST 31665 [3].

Conditions of carrying out GC analysis: quartz capillary column length 100 m, diameter – 0.25 mm, caused phase – cyano-propyltrichlorosilane. PID detector, carrier gas – nitrogen, the volume of injected sample was 1 μl. The initial temperature of thermostat column 140°C for 4 min, then programmed temperature rise at a rate of 3°C/min to 180°C – isotermic mode during the 40 min. The programmed temperature rise at a rate of 3°C/min to 240°C and isothermic mode for 25 min.

Identification of individual components was performed using standard mixtures of methyl esters of fatty acids Restek 35077 and Restek 35079, as well as on the basis of the known literature data on the retention indices of.

Quantitative content of fatty acids in the samples was determined by internal normalization using the package Unichrome®.

FSWs vegetable oils is quite complex, it includes basic acids such as oleic, palmitic, myristic, stearic, lauric, erucic, linoleic, γ-linolenic, α-linolenic, arachidonic etc. However, since the aim of this work was optimization of the FSWs in the ω-3 (linoleic) and ω-6 (α-linolenic), the main attention in the study of fatty acid composition was paid just to the content of these acids (Table 1).

Table 1

Fatty acid composition of vegetable oils

Oil sample	Linoleic, wt %	α-Linolenic, wt %
Sunflower	60	1
Corn	54	1
Rapeseed	29	6
Linseed	16	55

A study of fatty acid composition of natural oils showed that none of them has a balanced composition of polyunsaturated fatty acids, and therefore can not ensure entry to the human body the essential fatty acids in the right quantity and the right balance.

It was found that most of the PUFA family ω-3 contained in flax and rap-faced oil, and the family of ω-6 in the sunflower and corn nom.

Vegetable oil with a specified balanced fatty acid composition is obtained by mixing (blending).

In accordance with the recommendations of the Institute of nutrition, the ratio of ω-6 : ω-3 in ration of a healthy person should be 10 : 1 and for clinical nutrition from 3 : 1 to 5 : 1.

To calculate compositions of multicomponent blends of oils specialists of MGUPP the technique, taking into account the desired ratio of linoleic and linolenic acids, as well as the original content of these acids in the oils was proposed. The calculation is made according to the formulas (1) and (2):

$$\frac{m_a \cdot c_a^1 + m_b \cdot c_b^1}{m_a \cdot c_a^2 + m_b \cdot c_b^2} = 10; \quad (1)$$

$$m_a + m_b = 1, \quad (2)$$

where m_a, m_b is the mass of vegetable oil, kg; c_a^1, c_b^1 is the concentration of linoleic acid in vegetable oil, wt %; c_a^2, c_b^2 is the concentration of linolenic acid in vegetable oil, wt %.

On the basis of our calculations we proposed the blends of oils that are presented in Table 2.

Table 2

The compositions of blends of vegetable oils

Blends	Compounds (oil)	Blend composition, wt %	ω-6 : ω-3
1	Rapeseed + sunflower	92 : 8	5.6 : 1
2	Rapeseed + corn	92 : 8	5.5 : 1
3	Sunflower + linseed	91 : 9	9.6 : 1
4	Corn + linseed	91 : 9	8.5 : 1
5	Sunflower + rapeseed + linseed	15 : 80 : 5	4.3 : 1

It was further determined the main physical-chemical parameters (acid (AV) and peroxide number (FC)) of the obtained image CC blends of vegetable oils (Table 3) [4, 5].

Table 3

Physical and chemical characteristics of blends of vegetable oils

Blend	Acid number, mg KOH/kg	Peroxide number ½ O_2 mol/kg
1	0.2	2.3
2	0.2	3.0
3	0.4	2.3
4	0.4	2.5
5	0.4	2.9
The requirements of TNLA, no more	0.6	10.0

As can be seen from table 3, the obtained results meet the requirements, given to mixtures of edible oils. The results of these studies confirm the possibility of producing all the proposed mixtures of vegetable oils, as they fully meet the requirements of TU BY 190239501.136 "vegetable Oil – blend".

On the basis of the blends made in the laboratory of JSC "Minsk margarine plant" mayonnaise of 50% fat in the amount of 200 g were prepared. For this the recipe, which included blends of vegetable oils (49%), egg yolk, dry milk, sugar (sand), salt, stabilizer, acetic acid, natural flavoring "mustard essential Oil", water was developed.

To study the influence of changes in the fat-phase in the developed mayonnaise different from thestandard – sunflower oil refined, deodorized, on the taste organoleptic evaluation of the quality of mayonnaise was carried out. It was used descriptino profile method of the tasting analysis based on the requirements of STB ISO 6564 [6] and STB ISO 11036 [7]. The objects of the tasting were 5 developed samples, and as quality control sample – mayonnaise from the trading network made on the basis of sunflower oil. 40 respondents took part in the tasting.

The tasting was conducted in accordance with the following steps:

− preparation of panel of descriptors for these indicators of quality of mayonnaise like appearance and consistency, smell and taste, color;

− construction of the "perfect" profile in appearance and consistency, smell, and the taste of mayonnaise purchased in the trading network;

− evaluation of the organoleptic characteristics of the prototypes of mayonnaise.

To make panel of descriptors for appearance and consistency, smell and taste, color, the identification of the characteristic organoleptic quality indicators based on the experience of leading specialists of JSC "Minsky margarine plant" was conducted.

Of the identified characteristic of the perceived organoleptic indicators of quality of mayonnaise by expert method the most important were chosen, and they were included in the panel of descriptors (Table 4).

Organoleptic characteristics are determined in the following sequence: consistency, appearance, color, smell, taste.

In determining the appearance and color of mayonnaise a sample weighing not less than 30 g was placed in a glass beaker. Glass is placed on the sheet of white paper and is examined in diffused daylight, defining the appearance, color, and noting the absence or presence of impurities.

When determining the smell and taste mayonnaise in glass is pre-mixed with a spatula. The definition of the smell of mayonnaise is carried out organolepticall-y. In determining the taste quantity of the product must be sufficient for distribution throughout the oral cavity (3–10 g). The mayonnaise is kept in the mouth for 5–10 seconds, not swallowing, then it is removed.

Table 4

Panel of descriptors for quality mayonnaise indicators

Indicators	Descriptors
Appearance and consistency	Uniform
	Creamy
	Dense
	Liquid
	Mobile
	The lack of inclusions
Smell and taste	Sharp
	Sour
	Salt
	Sweet
	Spicy
	Bitter
	Milk
	Foreign flavor
Color	Light yellow
	Yellow
	Cream
	Light cream
	Yellowish-cream
	Uniform

In accordance with the preferences of respondents the "perfect" profiles in appearance and consistency, smell and taste, color of mayonnaise were created.

The intensity of each descriptor was determined using a 5-point scale presented in Table 5.

Table 5

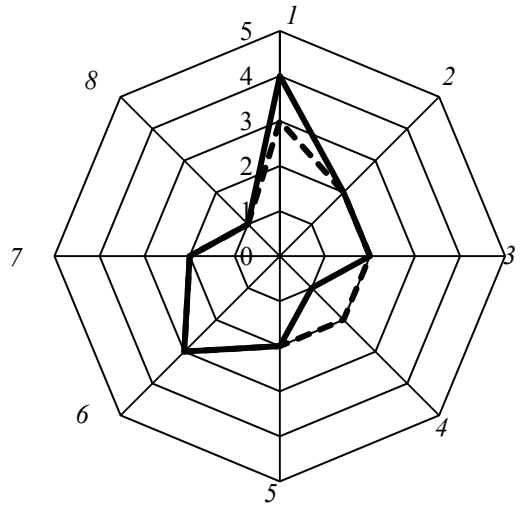
Point scale of determining the intensity of descriptors

Point	Description
1	No symptom
2	Low intensity
3	Moderate intensity
4	Strong
5	Very strong intensity

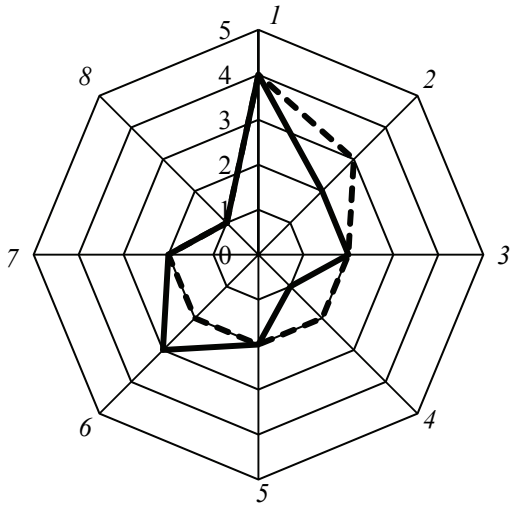
Scoring of the intensity of the descriptors was calculated as the average value of the ratings of the tasters.

Based on the results of determining the intensity of the descriptors the profiles of smell and taste was built. Profiles in appearance and the consistency and color were not presented, as all the samples had values close to "perfect". By comparing the profiles constructed with the "perfect" ones the most optimal mayonnaise were chosen, and on this basis the conclusion about possibility of application of the developed blends as raw materials for the production of functional food was made.

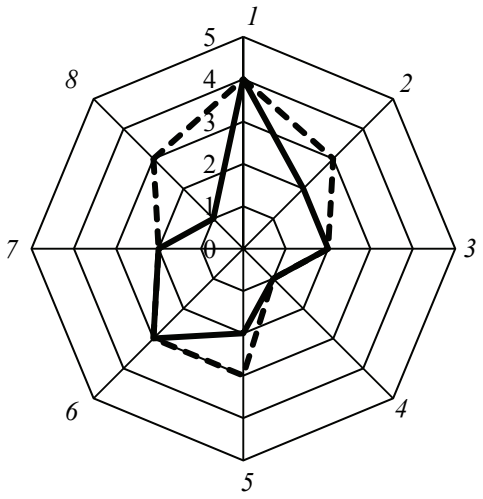
The figure shows the profilograms of smell and taste of the "perfect" and control samples of mayonnaise.



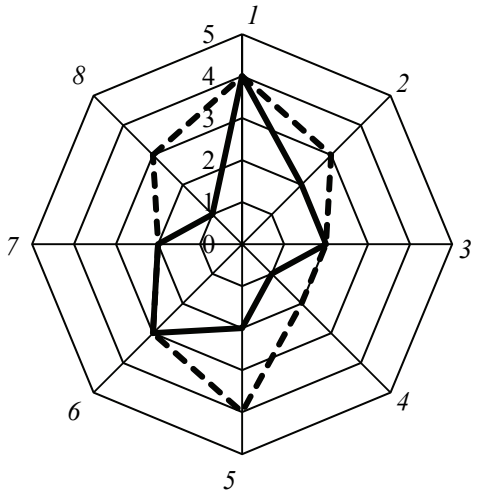
Sample 1



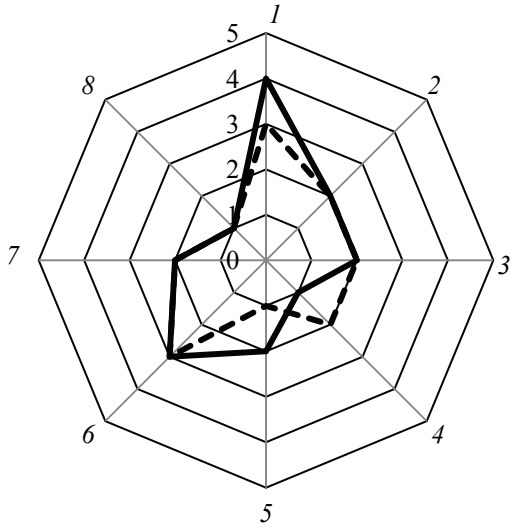
Sample 2



Sample 3



Sample 4



Sample 5

Profilograms of smell and taste of the "perfect" (—) and control samples (- - -) of mayonnaise:
1 – sour; *2* – sharp; *3* – salt; *4* – sweet; *5* – bitter; *6* – spicy; *7* – milk; *8* – foreign taste

Table 6

Physical and chemical characteristics of mayonnaise

Sample number of mayonnaise	Mass fraction of moisture, %, max	Mass fraction of of fat, %, no less	Acidity on acetic acid, %, max	Emulsion stability, % intact emulsion, no less
1	36.86	50.1	0.27	99.5
2	37.38	50.2	0.27	99.0
3	37.13	50.2	0.30	98.5
4	35.21	50.2	0.27	99.0
5	36.54	50.1	0.27	99.0
Requirements STB 2286	45.00	50.0	1.00	98.0

Table 7

Fatty acid composition of the fatty phase of the mayonnaise

Sample number	Linoleic, wt %	α-Linolenic, wt %	ω-6 : ω-3 the actual	ω-6 : ω-3 expected
1	34	6	5.7 : 1	5.6 : 1
2	26	4.5	5.8 : 1	5.5 : 1
3	42	6.7	6.3 : 1	9.6 : 1
4	36	6	6 : 1	8.5 : 1
5	32	8	4 : 1	4.3 : 1

As can be seen from the figure, the samples received a high enough rating, correlated with the control sample. Mayonnaises 1 and 5 received the closest to the perfect samples results. It should be noted that samples 3 and 4, according to the tasters had greater bitterness, which is caused by the content of 9% linseed oil.

The values of physico-chemical parameters of mayonnaise are presented in Table 6.

The obtained results conform to the requirements of the mayonnaise. The results of these studies confirm the possibility of producing the mayonnaise on all the blends because they are fully consistent with physical and chemical parameters, required by STB 2286 [8].

To determine the LCD composition of mayonnaise products it is necessary to conduct its separation into fat phase and water phase. For separation of mayonnaise emulsion a centrifuge with a rotational speed of 7,000 min^{-1} is used.

Fatty acid composition of the fatty phase of the mayonnaise was determined by gas-liquid chromatography (Table 7).

Conclusion. Thus, as a result of our work a new functional mayonnaise with a balanced fatty acid composition was obtained. The developed mayonnaise fully comply with the required physical and chemical parameters. However, some organoleptic characteristics of mayonnaise samples 3 and 4 – the bitterness (due to the introduction of flax oil) and the changing of their fatty acid composition should be noted.

Mayonnaises 1 and 2 respectively of rapeseed-sunflower and rapeseed-corn oils, as well as the 5th mayonnaise based on sunflower, rapeseed and linseed oils had organoleptic characteristics similar to the control sample, and they perfectly preserved their fatty acid composition, i.e. their functional properties were not lost in the process of manurfacture and storage.

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